DOCUMENT RESUME

ED 398 242 TM 025 155

AUTHOR Witta, E. Lea
TITLE Results of an Interactive Video Attitude Survey When Using the Total Group with Unequal Group Sizes versus Five Random Samples with Equal Group Sizes.
PUB DATE 25 Jan 96
NOTE 18p.; Paper presented at the Annual Meeting of the Southwest Educational Research Association (New Orleans, LA, January 1996).
PUB TYPE Reports - Research/Technical (143) -- Speeches/Conference Papers (150)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS Attitude Measures; *College Students; Distance Education; Higher Education; High Schools; *High School Students; *Interactive Video; Multivariate Analysis; *Sample Size; *Student Attitudes; Surveys
IDENTIFIERS *Group Size; Random Variables; Type I Errors; *Variance (Statistical)

ABSTRACT

A previous multivariate analysis of variance (MANOVA) study of attitudes toward interactive video (ITV) of participants in distance education had indicated that generalized variance was not homogeneous across all groups. Since heterogeneity of variance in MANOVA has previously been shown to change Type I error rates in unequal group size, detected differences were suspect. This study investigated whether the detected differences in attitude toward ITV would be identical if the total participant population with unequal group sizes were used or if random sampling of equal size groups was conducted. The analysis was conducted by using all participants (unequal group size) and by randomly selecting 31 subjects from each of 4 groups formed by site (home or remote site) and grade (high school or college). Random selection of 31 subjects per group and analysis was replicated 4 times. Results support the hypothesis that a larger generalized variance associated with a larger sample size does produce a conservative Type I error rate. These results also indicated that if there was no association between sample size and generalized variance, the effects of differences in variance will be canceled. When, however, the difference in generalized variance was less than two times the smaller, the hypothesis that Type I error was liberal did not occur. This suggests that there may be a minimum difference in variance (and possibly in sample size) to be exceeded before Type I error is seriously affected. (Contains three tables and five references.) (Author/SLD)

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Results of an Interactive Video Attitude Survey when Using the Total Group with Unequal Group Sizes versus Five Random Samples with Equal Group Sizes

E. Lea Witta

University of Southern Mississippi

Paper presented at the annual meeting of the South-west Educational Research Association, January 25, 1996.

TM025155

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Abstract

A two-way multivariate analysis of variance (MANOVA) based on location (home/remote site) and grade (college/high school) had previously been conducted using data produced by interactive video participants in a rural Appalachian area in southwest Virginia. A comparison of the generalized variance from this study revealed that the generalized variance was not homogeneous across all groups. Since heterogeneity of variance in MANOVA has previously been shown to change type I error rates in unequal group size, detected differences were suspect. The purpose of this study was to determine if the detected differences in attitude toward ITV would be identical if the total participant population with unequal group sizes were used or if random sampling of equal size groups was conducted.

This analysis was conducted using all participants (unequal group size) and by randomly selecting 31 subjects from each of the four groups formed by site and grade. Random selection of 31 subjects per group and analysis was replicated four times. Results from this study support the hypothesis that a larger generalized variance associated with larger sample size does produce a conservative type I error rate. These results also indicated that if there was no association between sample size and generalized variance, the effects of differences in variance will be canceled. When , however, the difference in generalized variance was less that two times the smaller, the hypothesis that type I error was liberal did not occur. This suggests that there may be a minimum difference in variance to be exceeded before type I error is seriously affected and possibly a minimum difference in sample size.

Results of an Interactive Video Attitude Survey when Using the Total Group with Unequal Group Sizes versus Five Random Samples with Equal Group Sizes

Increased use of interactive video (ITV) for distance learning students has made classes previously inaccessible to rural high school students available locally. College courses are also now offered at remote sites by interactive video permitting students to take the class without a lengthy drive. In some localities home bound students may now partake of classroom interaction by ITV. Thus, interactive video may be perceived as a means of providing equal educational opportunities to all students.

While interactive video may provide access to equal educational opportunities in rural areas, there is an increasing need for research into and evaluation of the effectiveness of ITV programs. Although ITV technology has advanced rapidly in recent years, there is increasing evidence that no one technology works in every application (Linking, 1989). In addition, since effectiveness of any program is related to a participant's perspective toward that program, attitude assessment is an essential component in evaluating a program. Assessment of participant attitudes is conducted by surveying the total current population as a representative sample of all participants (future or past) had they been currently enrolled, or sampling specific components of the current population. Using the total enrollment may produce unequal sample sizes with results which heterogeneity of variance may confound. Sampling for specified characteristics yields equal sample sizes, but may result in a reduction of power to detect differences.

A two-way multivariate analysis of variance (MANOVA) based on location (home/remote site) and grade (college/high school) was conducted on data produced by interactive video

participants in a rural Appalachian area in southwest Virginia. A comparison of the generalized variance from this study revealed that the generalized variance was not homogeneous across all groups. The purpose of this study was to determine if the detected differences in attitude toward ITV would be identical if the total current participant population with unequal group sizes were used or if random sampling of equal size groups was conducted.

Literature Review

Prior research by Holloway and Dunn (1967) revealed that the type I error rate changes due to heterogeneity of variance when using multivariate analysis of variance with unequal sample sizes. When the generalized variance of the larger group was three times that of the smaller group, the type I error rate decreased providing a more conservative test of the hypothesis (ie, dependent of difference in size of the two groups, type I error of .05 detected at a .01). When the generalized variance of the larger group was increased to 10 times that of the smaller, this effect was more pronounced. Using seven dependent variables, the type I error (.05) changed to .00 with group sizes of 15 and 35. Conversely when the larger generalized variance was associated with the smaller group, the type I error was liberal (ie, alpha of .05 detected at .09 with a magnitude of difference of 3). When the larger generalized variance was increased to 10 times the smaller variance, if the larger variance was associated with the smaller group type I error of .05 became .24.

Hakstian, Roed and Linn (1979) supported this finding but also added that severely unequal group size can produce large changes in the type I error even in cases of mild heterogeneity. They also demonstrated that the type I error is conservative if the larger variance is associated

with the larger group and liberal if the larger variance is associated with the smaller group. Stevens (1986) has added that if Box's M test for homogeneity of variance is significant with unequal group size, Hotellings trace is liberal if larger variance is associated with the smaller group and conservative if larger variance is associated with the larger group. He further adds if the Box's M test for homogeneity of variance is significant with equal groups size, then type I error is only slightly affected and if, in multiple groups, there is no association between variance and sample size, effects on type I error due variance differences will by group size will be canceled.

These findings lead to the following hypotheses for this study:

1. If variance is not associated with sample size, detected differences will be similar in the unequal and equal size samples.
2. If the larger variance is associated with the larger sample size significant differences detected in the total sample will also be detected in the equal size samples
3. If the larger variance is associated with the smaller sample size significant differences detected in the total sample will not be detected in the equal size samples

Method

All students enrolled in an interactive video class at a southwest Virginia facility during the Spring semester, 1995, were surveyed. Surveys were administered during the regularly scheduled class time by the class instructor or remote facilitator. One hundred eighty-four student surveys were returned. One of the returned surveys was unusable. Analysis was conducted using the

remaining 183. The sample was composed of 106 high school students (66 home site, 40 remote site) and 77 college students (46 home site, 31 remote site).

The survey instrument consisted of demographic information about the participant and 24 Likert type questions concerning the ITV program answered by all participants. Prior exploratory factor analysis on this questionnaire has suggested seven constructs which explain 64% of the variance for the 24 objective questions shared by both remote and home site students. Constructs established in this model consisted of ITV Program Evaluation accounting for 25% of the variance, Materials Support, Class Evaluation, Audio, Environment, Student Behavior, and Student Interaction.

Factor scores for each subject were obtained by multiplying the standardized score for each variable by the factor score coefficient (Norusis, 1988). If the variable was a missing value, the mean (0) was imputed. Factor scores were then used in a two way multivariate analysis of variance (MANOVA) in SPSS/PC+ to determine if there were statistically significant ($p \leq .05$) differences in the seven constructs forming this model by site or grade. If significant main or interaction effects were detected, the constructs contributing to significance were also determined. When detecting significance of contribution for the seven univariate constructs, the alpha level was changed to $\alpha \leq .01$. This analysis was conducted using all participants and by randomly selecting 31 subjects from each of the four groups formed by site and grade. Random selection of 31 subjects per group and analysis was replicated four times.

Results

When grouped by site and grade, their was no association between variability and sample

size (see Table 1). In this instance, a statistically significant interaction effect ($p \leq .05$) by grade and site was detected in all samples.. Class Evaluation and Audio contributed significantly ($\leq .01$) in the unequal group size sample. The audio construct contributed significantly ($p \leq .01$) to the interaction effect in all five equal size samples. The class evaluation and student behavior constructs contributed significantly to the interaction effect in only one of the five samples (see Table 1).

Insert Table 1 about here

The generalized variance for high school students (n=106) was 10 times larger than the variance of college students (n=77). A statistically significant ($p \leq .05$) main effect of grade was detected in all samples. The materials support construct contributed significantly to the main effect of grade in the unequal size sample and the equal size samples, while the student behavior construct contributed in the unequal size sample and four of the five equal size samples (see Table 2).

Insert Table 2 about here

The generalized variance for remote site students (n=71) was 1.6 times the variance of home site students (n=112). Both materials support and audio contributed to the significant main effect of site in the unequal size sample and one of the equal size samples. In the other equal size

sample with a significant main effect of site, only multivariate significance was detected. No individual contributor was significant (see Table 3).

Insert Table 3 about here

Discussion

When the generalized variance did not vary consistently with sample size, a significant interaction effect was detected in the unequal size groups. Detection of a significant multivariate interaction effect in all five randomly selected samples supports the total group finding of a multivariate interaction effect and hypothesis 1. There was, however, a discrepancy between other contributors. One of the equal size samples also detected the student behavior construct as a significant contributor. This construct was not statistically significant in the unequal group size sample or in the other four equal size samples. This specific instance probably reflects sampling variability. In addition, the class evaluation construct was detected as a significant contributor in the unequal group size sample and one equal group size sample.

It was also hypothesized that if the generalized variance was larger for the larger group since MANOVA procedures are conservative, significant differences detected in the unequal group size sample would also be detected in the equal group size sample. This hypothesis was supported by the factor grade. In this instance, the larger variance was associated with the larger group. A statistically significant main effect was detected in all samples. The Materials Support construct was a significant contributor to multivariate significance in each sample. Student behavior was a

significant contributor in all samples except one.

Statistically significant main effects were also detected in the unequal size group sample for site. The larger generalized variance was associated with the smaller group size for this factor. As hypothesized, statistical significance was not detected in three of the equal size samples. Significance was, however, detected in two of the equal size samples. In one of the significant equal size group samples and the unequal group sample, the contributors to multivariate significance were materials support and audio. In the other equal size group sample, only multivariate significance was detected. This suggests that the variability difference between sites (1.6 times) may not have been sufficiently different to cause the hypothesized results.

Conclusion

Results from this study support the hypothesis that a larger generalized variance associated with larger sample size does produce a conservative type I error rate. These results also indicated that if there was no association between sample size and generalized variance, the effects of differences in variance will be canceled.

When , however, the difference in generalized variance was less that two times the smaller, the hypothesis that type I error was liberal did not occur. This suggests that there may be a minimum difference in variance to be exceeded before type I error is seriously affected and possibly a minimum difference in sample size. Further research is needed to determine what these minimum differences may be.

It is suggested that researchers using multivariate analysis of variance examine the difference between the generalized variances for groups. If larger variance is associated with larger group

they may feel relatively certain that type I error is conservative. If larger variance is associated with the smaller groups, examine the magnitude of difference. If less than 1.6, the effect should be minor. If, however, the magnitude of difference is larger than 1.6, type I error may be inflated.

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Table 1

Interaction Effect Using the Total Sample and Five Randomly Selected Samples

			Factors Contributing to Multivariate Significance F						
Source	df	T^2 $F_{approx.}$	ITV Prog Evaluatn	Materials Support	Class Evaluatn	Audio	Envrmnt	Student Behavior	Student Intractn
Total	7	3.95***	.40	.67	6.92**	12.24**	1.66	3.51	1.43
Sample 1	7	4.23***	.08	2.68	2.63	12.61***	3.79	7.34**	.06
Sample 2	7	2.68*	.19	.50	3.03	9.21**	2.26	.97	1.20
Sample 3	7	5.45***	.02	.46	5.62	17.22***	2.25	3.12	2.95
Sample 4	7	3.96**	1.23	.74	4.91	7.71**	1.28	3.91	5.03
Sample 5	7	3.89**	.07	1.00	7.82**	12.38***	1.10	1.28	1.08

Note. Determinants: HS-home=.38 (n=66);HS-remote=.53 (n=40);Coll-home=.02 (n=46);Coll-remote=.03 (n=31). df (total error =173; sample error 114; total contributors 1, 179; sample contributors 1, 120). * p≤.05. **p≤.01. ***P≤.001.

Table 2

Grade Main Effect Using the Total Sample and Five Randomly Selected Samples

			Factors Contributing to Multivariate Significance						
						F			
Source	df	T^2 F_{approx}	ITV Prog Evaluatn	Materials Support	Class Evaluatn	Audio	Student Envrmnt	Student Behavior	Intractn
Total	7	9.45***	1.02	24.46***	5.53	.42	2.62	14.03***	5.34
Sample 1	7	8.03**	.80	18.77***	4.21	1.16	2.20	12.19***	5.32
Sample 2	7	7.75**	.79	18.69***	5.81	.07	5.48	4.98	4.92
Sample 3	7	7.62***	1.31	18.47***	3.18	1.52	3.43	9.97**	3.69
Sample 4	7	6.42***	.01	12.43**	5.98	.15	1.62	15.13***	1.34
Sample 5	7	6.96***	1.12	16.45***	3.33	.38	1.79	9.31**	2.49

Note. Determinants: High School=.77 (n=106); College=.07 (n=77).

df (total error =173; sample error 114; total contributors 1, 179; sample contributors 1, 120).

* p≤.05. **p≤.01. ***P≤.001.

Table 3

Site Main Effect Using the Total Sample and Five Randomly Selected Samples

			Factors Contributing to Multivariate Significance						
						F			
Source	df	T^2 $F_{approx.}$	ITV Prog Evaluatn	Materials Support	Class Evaluatn	Audio	Envrmnt	Student Behavior	Student Intractn
Total	7	2.90**	.22	8.23**	3.12	6.61*	.91	.02	.05
Sample 1	7	3.39**	.26	9.77**	2.08	7.19**	1.00	.58	.76
Sample 2	7	1.22							
Sample 3	7	1.85							
Sample 4	7	1.71							
Sample 5	7	2.22*	.24	6.57	2.54	3.66	1.29	.00	.03

Note. Determinants: Home=.37 (n=112); Remote=.61 (n=71).

df (total error =173; sample error 114; total contributors 1, 179; sample contributors 1, 120).

* p≤.05. **p≤.01. ***P≤.001.

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